



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY  
AND POLLUTION PREVENTION

December 19, 2013

MEMORANDUM

**Subject:** Human Health Risk Assessment of the Label Amendment for the Use of Vital Oxide Applied by Fogging

|                                    |   |
|------------------------------------|---|
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| Petition No(s): NA                 | Regulatory Action: Label Amendment            |
| Risk Assess Type: Human Health     | Case No(s): NA                                |
| TXR No.: NA                        | CAS No(s): 10049-04-4, 53516-76-0, 85409-23-0 |
| MRID No(s): 48753402, 48667903     | 40 CFR: NA                                    |

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This memo is a human health risk assessment of the proposed amended use of Vital Oxide as a disinfectant applied by fogging. Vital Oxide contains liquid chlorine dioxide and two quaternary ammonium (quat) chemicals (alkyl dimethyl benzyl ammonium chloride and alkyl dimethyl ethyl benzyl ammonium chloride). This assessment indicates that risks to the quats may be of concern depending upon the cycle times and the capacity of the Z-vac evacuation system.

**Regulatory Note** – This assessment relies on an inhalation toxicity study (MRID 48667903) that was conducted using didecyl dimethyl ammonium chloride (DDAC) and thus data compensation may be required.

## Introduction

The label for Vital Oxide (#82972-1) is proposed to be amended to include fogging application to disinfect hard non-porous surfaces. These applications will be made using the Zimek Micro-Mist Decontamination System which distributes a low volume mist to enclosed spaces up to 3400 cubic feet (ft<sup>3</sup>) in volume. The proposed use sites include health care facilities, such as hospitals and nursing homes, emergency vehicles, public access areas, such as schools, restaurants, and day care centers, meat and poultry processing plants, poultry houses, hatcheries, and transportation vehicles, such as airplanes, buses and ships.

## Potential Exposures

This product contains 0.30 percent chlorine dioxide, 0.125 percent alkyl dimethyl benzyl ammonium chloride (ADBAC) and 0.125 percent alkyl dimethyl ethyl benzyl ammonium chloride (ADBAC ethyl). The product is a liquid. As discussed in D413896, chlorine dioxide is the form of sodium chlorite in a “stabilized” buffered solution. The buffered solution is applied as an aqueous fog or mist and when it contacts cell walls of the target organisms it releases chlorine dioxide. Given this information, it is unlikely that chlorine dioxide gas would be released, and thus these exposures do not need to be quantitatively assessed. There is a potential; however, for inhalation exposure to aerosols containing ADBAC and ADBAC ethyl. It is anticipated that these exposures would be of short to intermediate term duration (i.e. 1 to 180 days) for patients and long term in duration for hospital staff.

## Toxicology Endpoints for ADBAC

For this assessment only, the inhalation toxicology endpoint for was selected from a four week inhalation toxicity study in rats (MRID 48667903) conducted with didecyl dimethyl ammonium chloride (DDAC). There is no inhalation toxicity study available for ADBAC; however, the irritation effects observed in the DDAC inhalation toxicity study are expected to occur at an equal or lesser concentration compared to ADBAC. The NOAEL from the study was first adjusted to account for differences in exposure duration between the animal study (6 hours) and the relevant human exposure duration (8 hours) and was then converted to a human equivalent concentration (HEC) using the equation

$$\text{HEC} = \text{NOAEL}_{\text{ADJ}} \times \text{DAF}$$

Where the DAF (dosimetric adjustment factor) represents a factor that adjusts the animal concentration to a human equivalent concentration for the regions of the respiratory tract where the chemical is deposited. For calculation of the DAF, the Regional Deposited Dose Ratio (RDDR) program was used.

| Table 1 – Inhalation Toxicity Endpoint for ADBAC     |  |                 |  |
|--|--|-----------------|--|
| Exposure Scenario                                    | HEC Used in Risk Assessment                | Target MOE      | Study and Toxicological Endpoints  |
| Occupational Exposures<br>(8 hours/day, 5 days/week) | HEC <sup>A</sup> = 0.02 mg/m <sup>3</sup>  | 30 <sup>C</sup> | MRID 48667903 – 4 week Aerosol Inhalation Toxicity study of DDAC where the rats were exposed 6 hours/day and 5 days/ week.<br><br>LOAEL = 0.5 mg/m <sup>3</sup> based on pathological findings in the respiratory tract.<br>NOAEL = 0.08 mg/m <sup>3</sup> .<br><br>RDDR = 0.268 for extrathoracic effects |
| Residential Exposures<br>(24 hours/day, 7 days/week) | HEC <sup>B</sup> = 0.004 mg/m <sup>3</sup> | 30 <sup>C</sup> | Same as above.   |

Notes for Table 1

A. HEC Occupational = NOAEL\* RDDR \* [6 hr day rat / 8 hr day human] \* [5 day week rat/5 day week human].

B. HEC Residential = NOAEL\* RDDR \* [6 hr day rat / 24 hr day human] \* [5 day week rat/7 day week human].

C. Includes safety factors of 10X for intraspecies variability and 3X for interspecies extrapolation.

## Occupational and Residential Exposure

Vital Oxide can be used only with a Zimek ROC-HC Micro-Mist Generator in conjunction with the Zimec Z-vac Micro-Particle Evacuator. These devices are run automatically using a computerized treatment cycle. The treatment consists of an application phase, a dwell phase and an evacuation phase as detailed in the Zimek –ML-Health Care Micro-Mist System User Guide of July 2013. This guide also includes user safety instructions to ensure that the fog does not leak out of the room during treatment and that the fog is removed from the room after treatment and prior to occupancy. These instructions include the use of Zimek Micro-Mist Containment Devices to seal HVAC vents, and the use of plastic wrap and Zimek approved tape to seal door jambs and windows. The instructions also include procedures for re-entry of the decontaminated room following treatment. These procedures indicate that operators enter the room only after the Z-vac evacuation cycle is completed and that if respiratory or eye irritation is experienced upon room re-entry, then the Z-vac must be operated in manual mode until such irritation ceases.

### Application Rates

The label and user manual do not directly specify the application rates. The manual indicates that one of three preprogrammed application scenarios (standard room, standard room with ante room, or deluxe room) can be selected. The manual also indicates that it is possible to change the times for the preprogrammed applications or to program custom applications; however, it contains a disclaimer that Zimek is not liable for injuries or damages arising from such changes. The application rates that correspond to the above application scenarios are listed in Table 2 below. These rates are from a risk assessment (Whitmyre, 2013) that was submitted in support of the label amendment.

| <b>Table 2 – Application Rates for Vital Oxide Fogging of Healthcare Facilities</b> |                              |                               |   |  |   |   |  |
|---|------------------------------|-------------------------------|---|--|---|---|--|
| <b>Application Scenario</b>   | <b>Area (ft<sup>2</sup>)</b> | <b>Volume (m<sup>3</sup>)</b> | <b>Fogging Time<sup>C</sup> (minutes)</b> | <b>Amount Product Applied<sup>D</sup> (ml)</b> | <b>Product Air Concentration<sup>E</sup> (mg/m<sup>3</sup>)</b> | <b>Mass Quats Released<sup>F</sup> (mg)</b> | <b>QuatsAir Concentration<sup>G</sup> (mg/m<sup>3</sup>)</b> |
| Standard Hospital Space   | 225                          | 51 <sup>A</sup>               | 15  | 750  | 14,700  | 1,880                                       | 36.9   |
| Deluxe Hospital Space   | 275                          | 62 <sup>A</sup>               | 25  | 1250   | 20,200  | 3,130                                       | 50.5   |
| Hospital Isolation Space  | 313                          | 71 <sup>A</sup>               | 30  | 1500   | 21,100  | 3,750                                       | 52.8   |
| Ambulance   | 100                          | 17 <sup>B</sup>               | 10  | 500  | 29,400  | 1,250                                       | 73.5   |

Notes for Table 2

- A. Based on a ceiling height of 8 ft and converted to m<sup>3</sup> (m<sup>3</sup> = ft<sup>3</sup>\*28.3 liter/ft<sup>3</sup>\* 0.001 liter/m<sup>3</sup>)  
B. Based on a ceiling height of 6 feet.  
C. As listed in Table 5 of Whitmyre, 2013.  
D. Based on the application time and the MicroMist nozzle flow rate of 50 ml/minute.  
E. Based on the amount product applied (1 ml = 1 gm) divided by the room volume.  
F. Based on the amount product applied times the ai content (0.25 percent ai by weight)  
G. Based on the mass of quats released divided by the room volume.

Calculation Methods

The air concentrations after evacuation using the Z-vac and using ventilation were calculated using the following single chamber ventilation formula that is included in the EPA Multi-Chamber Concentration and Exposure Model (MCCCEM):

$$C_T = C_0 * 0.5 [(T/0.693) * (Q/V)]$$

Where:

C<sub>T</sub> = Air concentration at time T

C<sub>0</sub> = Air Concentration at time zero

Q = Evacuation or Ventilation rate in cubic feet per minute (CFM)

T = Elapsed time in minutes

V = Volume of room in cubic feet

Assumptions Used

The following assumptions were used in assessing the exposures to Vital Oxide:

- Since the Z-vac evacuation rate is not known, the amount of airflow needed to generate acceptable MOEs was back calculated using a range of evacuation cycle times.

- It is assumed that the filters in the Z-vac unit are capable of removing the vital oxide aerosols with an efficiency of 90 percent based on the information provided in (Whitmyre, 2013). This efficiency was used to adjust the needed airflow.
- The air exchange rate for patient rooms is 2.0 air changes per hour (ACH). This rate is specified in design guidelines from the American Institute of Architects (AIA) and the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) as discussed in (Begg, 2008). It should be noted that this is the air exchange rate for outdoor air and that this does not include the recirculated air that is included in the recommended total air exchange rate of 6.0 ACH.
- The daily exposure duration is 24 hours for patients and 8 hours for hospital staff.

## Results

The results in terms of the Z-vac airflow rates and evacuation times needed to achieve the target MOE of 30 for ADBAC exposure are listed in Table 3. In general, higher flow rates and/or longer evacuation times are needed to achieve the target MOE for patients than for workers because the patients have a longer exposure time. At the shortest evacuation time of 20 minutes the required Z-vac flow rates range from 870 Cubic Feet of Air per Minute (CFM) for standard rooms to 1250 CFM for isolation rooms. With an evacuation time of 60 minutes, the required flow rates range from 290 CFM to 420 CFM. The required flow rates for ambulance treatment are much lower and range from 290 CFM with a 20 minute evacuation time to 99 CFM with 60 minute evacuation time.

| <b>Room Type</b>                 | <b>ADBAC in Air after Application (mg/m<sup>3</sup>)</b> | <b>Filtration Time (minutes)</b> | <b>Z-vac Flow Rate (CFM)</b> | <b>ADBAC in Air After Filtration (mg/m<sup>3</sup>)</b> | <b>ADBAC in Air 24 hr TWA (mg/m<sup>3</sup>)</b> | <b>24 hr MOE*</b> | <b>ADBAC in Air 8 hr TWA (mg/m<sup>3</sup>)</b> | <b>8 hr MOE*</b> |
|----------------------------------|--|----------------------------------|------------------------------|---|--|-------------------|---|------------------|
| Standard (225 ft <sup>2</sup> )  | 36.9   | 20<br>30<br>60                   | 870<br>580<br>290            | 0.0063  | 0.00013  | 30                | 0.00040   | 50               |
| Deluxe (275 ft <sup>2</sup> )    | 50.5   | 20<br>30<br>60                   | 1100<br>730<br>370           | 0.0062  | 0.00013  | 30                | 0.00040   | 50               |
| Isolation (313 ft <sup>2</sup> ) | 52.8   | 20<br>30<br>60                   | 1250<br>840<br>420           | 0.0059  | 0.00013  | 30                | 0.00040   | 50               |
| Ambulance (100 ft <sup>2</sup> ) | 73.5   | 20<br>30<br>60                   | 290<br>200<br>100            | 0.010   | N/A  | N/A               | 0.00065   | 30               |

\*The target MOE is 30 for Patient (24 hr TWA) and Worker (8 hr TWA) Exposures.

## Comparison to Measured Concentrations

In an aerosol characterization study (MRID 48753402), aerosol particle size and mass concentrations were measured during and after treatment of a 100 m<sup>3</sup> test chamber using undiluted Vital Oxide. The treatment was made using the Zimek Touch Free Rapid

Decontamination System (ROC-ML) and the evacuation was made using the Z-vac Micro-particle Evacuator. The measurements were made using a TSI Aerodynamic Particle Sizer (APS) Model 3321. A total of four application runs were conducted with application-dwell-evacuation times of 25-10-25 minutes (runs 1, 2 and 3) or 60-30-30 minutes (run 4). During runs 1 and 2 the APS was located inside the chamber and during runs 3 and 4 the APS was located outside the chamber and connected to the chamber interior via a 5 foot long poly sampling tube. This was done because excessive moisture caused the APS to shut down during runs 1 and 2. The APS shut down during the dwell period following the application during run 1 and during the middle of the application during run 2.

During runs 1 and 3 the peak total aerosol mass was 507.3 and 251.7 mg/m<sup>3</sup> after the application cycle. These concentrations declined to 0.03 mg/m<sup>3</sup> during the 25 minute evacuation cycle. The mass median aerodynamic diameter (MMAD) ranged from 2 um at the beginning of the application cycle to a maximum of 10 um at the end of the application cycle. The MMAD then declined to 2 microns during the first ten minutes of the decontamination cycle.

During run 4 the peak total aerosol mass was 100 mg/m<sup>3</sup> after the application cycle. The concentration then declined to approximately 3 mg/m<sup>3</sup> during the 30 minute dwell cycle and to less than 0.01 mg/m<sup>3</sup> during the evacuation cycle. The MMAD ranged from 2 um at the beginning of the application cycle to a maximum of 4 um at the end of the application cycle. The MMAD then declined to 1 micron during the first ten minutes of the evacuation cycle.

While the above study is useful for characterizing the particle sizes and mass concentrations during and after a Vital Oxide application, it is important to note that the Z-vac microparticle evacuator was of a different type than is shown in the 2013 User Guide. The Z-vac used in the study was of a rectangular design that had particulate filters only while the newer Z-vac shown in the user guide is of a cylindrical design with particulate filters and a Purafil adsorbent cartridge.

## Conclusions

The results indicate that, depending upon the room size and evacuation rate, a Z-vac flow rate of 100 to 1,250 CFM is needed to achieve the target MOE of 30. Given the design characteristics of the original Z-vac, which only contains particulate filters of a fairly large surface area, it is likely that it provides more than 1,250 CFM. Given the design of the new Z-vac, which also contains a Purafil Canister (rated at 125 CFM @ 0.5 inches static pressure) that has a much smaller surface area than the particulate filters, it is likely that new Z-vac provides less than 1,250 CFM. It is therefore recommended that one of the following three actions be taken:

1. Modify the new Z-vac to remove the Purafil cannister and to increase the size of the fan inlet.
2. Increase the evacuation times when using the new Z-vac for Vital Oxide applications.
3. Only use the original Z-vac for Vital Oxide applications.

## **Appendices**

### Appendix A – ADBAC Air Concentrations for Vital Oxide Fogging

**References:**

Begg et al, 2008. The Ventilation of Multiple-Bed Hospital Wards: Review and Analysis, Journal of the Association of Infection Control, Volume 36, Number 4, 7/12/ 2007. pp 250-258.

D413896. Evaluation of the Zimek device for the generation of chlorine dioxide. US EPA Memorandum from A. Najm Shamim to Jaclyn Pyne, November 18, 2013.

MRID 48667903. Weinber, J.T. (2011) Maquat 4450-E: A 4 week Aerosol Inhalation Toxicity Study with a 2- week Recovery Period in Sprague-Dawley Rats. WIL Research Laboratories, LLC (Ashland, OH). WIL-782002, 31, October 2011.

MRID 48753402. Aerosol Characterization for Zimek's Touch-Free Rapid Decontamination System (ROC-ML), Project 10764.1, Aerosol Research and Engineering Laboratories, 12/16/2011

Whitmyre, 2013 Risk Assessment of Applicator, Reentry and Post-Application Bystander Exposures to the Active Ingredients of Vital Oxide when Used with the Zimek Micro-Mist<sup>R</sup> Decontamination System, G.K. Whitmyre, July 31,2013. Unpublished.

## Appendix A - Quat Air Concentrations for Vital Oxide Fogging

### Spreadsheet 1 -Standard Room

#### Application Assumptions

|                             |               |
|-----------------------------|---------------|
| Amount Ai in Product        | 0.25 percent  |
| Application Rate of Product | 50 cm3/minute |
| Application Time            | 15 Minutes    |
| Amount Product Applied      | 750 cm3       |
| Amount Ai Applied           | 1875 mg       |

#### Evacuation and Ventilation Assumptions

|                                     |          |
|-------------------------------------|----------|
| Room Size                           | 225 ft2  |
| Room Volume (Assuming 8 ft ceiling) | 1800 ft3 |
| Room Volume                         | 51 m3    |
| Evacuation Rate                     | 260 CFM  |
| Ventilation Rate                    | 60 CFM   |
| Evacuation Air Changes per Hour     | 8.7      |
| Ventilation Air Changes per Hour    | 2.0      |

|   |              |
|---|--------------|
| HEC for Residential Exposures (24 hr TWA) | 0.0040 mg/m3 |
| HEC for Occupational Exposures (8 hr TWA) | 0.0200 mg/m3 |
| Target MOE (Occupational and Residential) | 30           |

#### Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

#### Decline During Evacuation Cycle

##### Cycle Time = 20 Minutes

##### Cycle Time = 30 Minutes

##### Cycle Time = 60 Minutes

| Time (Min) | Zone 1 (mg/m3)  | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 Hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE |
|------------|-----------------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|
| 0          | 36.81           | 0          | 2.05E+00       | 4.33E-02          | 0         | 1.29E-01         | 0        | 0          | 4.83E-01       | 1.02E-02          | 0         | 3.05E-02         | 1        | 0          | 6.33E-03       | 1.34E-04          | 30        |
| 1          | 31.86           | 1          | 1.98E+00       |                   |           |                  |          | 1          | 4.67E-01       |                   |           |                  |          | 1          | 6.12E-03       |                   |           |
| 2          | 27.57           | 2          | 1.91E+00       |                   |           |                  |          | 2          | 4.51E-01       |                   |           |                  |          | 2          | 5.92E-03       |                   |           |
| 3          | 23.86           | 3          | 1.85E+00       |                   |           |                  |          | 3          | 4.37E-01       |                   |           |                  |          | 3          | 5.73E-03       |                   |           |
| 4          | 20.65           | 4          | 1.79E+00       |                   |           |                  |          | 4          | 4.22E-01       |                   |           |                  |          | 4          | 5.54E-03       |                   |           |
| 5          | 17.87           | 5          | 1.73E+00       |                   |           |                  |          | 5          | 4.09E-01       |                   |           |                  |          | 5          | 5.36E-03       |                   |           |
| 6          | 15.47           | 6          | 1.68E+00       |                   |           |                  |          | 6          | 3.95E-01       |                   |           |                  |          | 6          | 5.18E-03       |                   |           |
| 7          | 13.39           | 7          | 1.62E+00       |                   |           |                  |          | 7          | 3.82E-01       |                   |           |                  |          | 7          | 5.01E-03       |                   |           |
| 8          | 11.59           | 8          | 1.57E+00       |                   |           |                  |          | 8          | 3.70E-01       |                   |           |                  |          | 8          | 4.85E-03       |                   |           |
| 9          | 10.03           | 9          | 1.52E+00       |                   |           |                  |          | 9          | 3.58E-01       |                   |           |                  |          | 9          | 4.69E-03       |                   |           |
| 10         | 8.68            | 10         | 1.47E+00       |                   |           |                  |          | 10         | 3.46E-01       |                   |           |                  |          | 10         | 4.53E-03       |                   |           |
| 11         | 7.51            | 11         | 1.42E+00       |                   |           |                  |          | 11         | 3.34E-01       |                   |           |                  |          | 11         | 4.39E-03       |                   |           |
| 12         | 6.50            | 12         | 1.37E+00       |                   |           |                  |          | 12         | 3.23E-01       |                   |           |                  |          | 12         | 4.24E-03       |                   |           |
| 13         | 5.63E+00        | 13         | 1.33E+00       |                   |           |                  |          | 13         | 3.13E-01       |                   |           |                  |          | 13         | 4.10E-03       |                   |           |
| 14         | 4.87E+00        | 14         | 1.28E+00       |                   |           |                  |          | 14         | 3.03E-01       |                   |           |                  |          | 14         | 3.97E-03       |                   |           |
| 15         | 4.21E+00        | 15         | 1.24E+00       |                   |           |                  |          | 15         | 2.93E-01       |                   |           |                  |          | 15         | 3.84E-03       |                   |           |
| 16         | 3.65E+00        | 16         | 1.20E+00       |                   |           |                  |          | 16         | 2.83E-01       |                   |           |                  |          | 16         | 3.71E-03       |                   |           |
| 17         | 3.16E+00        | 17         | 1.16E+00       |                   |           |                  |          | 17         | 2.74E-01       |                   |           |                  |          | 17         | 3.59E-03       |                   |           |
| 18         | 2.73E+00        | 18         | 1.12E+00       |                   |           |                  |          | 18         | 2.65E-01       |                   |           |                  |          | 18         | 3.47E-03       |                   |           |
| 19         | 2.36E+00        | 19         | 1.09E+00       |                   |           |                  |          | 19         | 2.56E-01       |                   |           |                  |          | 19         | 3.36E-03       |                   |           |
| 20         | <b>2.05E+00</b> | 20         | 1.05E+00       |                   |           |                  |          | 20         | 2.48E-01       |                   |           |                  |          | 20         | 3.25E-03       |                   |           |



## Appendix A - Quat Air Concentrations for Vital Oxide Fogging

### Spreadsheet 2 -Deluxe Room

#### Application Assumptions

|                             |               |
|-----------------------------|---------------|
| Amount Ai in Product        | 0.25 percent  |
| Application Rate of Product | 50 cm3/minute |
| Application Time            | 25 Minutes    |
| Amount Product Applied      | 1250 cm3      |
| Amount Ai Applied           | 3125 mg       |

#### Evacuation and Ventilation Assumptions

|                                     |          |
|-------------------------------------|----------|
| Room Size                           | 275 ft2  |
| Room Volume (Assuming 8 ft ceiling) | 2200 ft3 |
| Room Volume                         | 62 m3    |
| Evacuation Rate                     | 330 CFM  |
| Ventilation Rate                    | 75 CFM   |
| Evacuation Air Changes per Hour     | 9.0      |
| Ventilation Air Changes per Hour    | 2.0      |

|   |              |
|---|--------------|
| HEC for Residential Exposures (24 hr TWA) | 0.0040 mg/m3 |
| HEC for Occupational Exposures (8 hr TWA) | 0.0200 mg/m3 |
| Target MOE (Occupational and Residential) | 30           |

#### Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

#### Decline During Evacuation Cycle

##### Cycle Time = 20 Minutes

##### Cycle Time = 30 Minutes

##### Cycle Time = 60 Minutes

| Time (Min) | Zone 1 (mg/m3)  | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 Hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE |
|------------|-----------------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|
| 0          | 50.19           | 0          | 2.50E+00       | 5.17E-02          | 0         | 1.55E-01         | 0        | 0          | 5.57E-01       | 1.15E-02          | 0         | 3.45E-02         | 1        | 0          | 6.18E-03       | 1.28E-04          | 31        |
| 1          | 43.20           | 1          | 2.41E+00       |                   |           |                  |          | 1          | 5.38E-01       |                   |           |                  |          | 1          | 5.98E-03       |                   |           |
| 2          | 37.18           | 2          | 2.33E+00       |                   |           |                  |          | 2          | 5.20E-01       |                   |           |                  |          | 2          | 5.77E-03       |                   |           |
| 3          | 32.00           | 3          | 2.25E+00       |                   |           |                  |          | 3          | 5.03E-01       |                   |           |                  |          | 3          | 5.58E-03       |                   |           |
| 4          | 27.54           | 4          | 2.18E+00       |                   |           |                  |          | 4          | 4.86E-01       |                   |           |                  |          | 4          | 5.39E-03       |                   |           |
| 5          | 23.71           | 5          | 2.11E+00       |                   |           |                  |          | 5          | 4.70E-01       |                   |           |                  |          | 5          | 5.21E-03       |                   |           |
| 6          | 20.40           | 6          | 2.04E+00       |                   |           |                  |          | 6          | 4.54E-01       |                   |           |                  |          | 6          | 5.04E-03       |                   |           |
| 7          | 17.56           | 7          | 1.97E+00       |                   |           |                  |          | 7          | 4.39E-01       |                   |           |                  |          | 7          | 4.87E-03       |                   |           |
| 8          | 15.11           | 8          | 1.90E+00       |                   |           |                  |          | 8          | 4.24E-01       |                   |           |                  |          | 8          | 4.71E-03       |                   |           |
| 9          | 13.01           | 9          | 1.84E+00       |                   |           |                  |          | 9          | 4.10E-01       |                   |           |                  |          | 9          | 4.55E-03       |                   |           |
| 10         | 11.20           | 10         | 1.78E+00       |                   |           |                  |          | 10         | 3.96E-01       |                   |           |                  |          | 10         | 4.40E-03       |                   |           |
| 11         | 9.64            | 11         | 1.72E+00       |                   |           |                  |          | 11         | 3.83E-01       |                   |           |                  |          | 11         | 4.25E-03       |                   |           |
| 12         | 8.29            | 12         | 1.66E+00       |                   |           |                  |          | 12         | 3.70E-01       |                   |           |                  |          | 12         | 4.11E-03       |                   |           |
| 13         | 7.14E+00        | 13         | 1.60E+00       |                   |           |                  |          | 13         | 3.58E-01       |                   |           |                  |          | 13         | 3.97E-03       |                   |           |
| 14         | 6.14E+00        | 14         | 1.55E+00       |                   |           |                  |          | 14         | 3.46E-01       |                   |           |                  |          | 14         | 3.84E-03       |                   |           |
| 15         | 5.29E+00        | 15         | 1.50E+00       |                   |           |                  |          | 15         | 3.34E-01       |                   |           |                  |          | 15         | 3.71E-03       |                   |           |
| 16         | 4.55E+00        | 16         | 1.45E+00       |                   |           |                  |          | 16         | 3.23E-01       |                   |           |                  |          | 16         | 3.58E-03       |                   |           |
| 17         | 3.92E+00        | 17         | 1.40E+00       |                   |           |                  |          | 17         | 3.12E-01       |                   |           |                  |          | 17         | 3.46E-03       |                   |           |
| 18         | 3.37E+00        | 18         | 1.35E+00       |                   |           |                  |          | 18         | 3.02E-01       |                   |           |                  |          | 18         | 3.35E-03       |                   |           |
| 19         | 2.90E+00        | 19         | 1.31E+00       |                   |           |                  |          | 19         | 2.91E-01       |                   |           |                  |          | 19         | 3.23E-03       |                   |           |
| 20         | <b>2.50E+00</b> | 20         | 1.26E+00       |                   |           |                  |          | 20         | 2.82E-01       |                   |           |                  |          | 20         | 3.13E-03       |                   |           |

## Appendix A - Quat Air Concentrations for Vital Oxide Fogging

### Spreadsheet 3 -Isolation Room

#### Application Assumptions

|                             |               |
|-----------------------------|---------------|
| Amount Ai in Product        | 0.25 percent  |
| Application Rate of Product | 50 cm3/minute |
| Application Time            | 30 Minutes    |
| Amount Product Applied      | 1500 cm3      |
| Amount Ai Applied           | 3750 mg       |

#### Evacuation and Ventilation Assumptions

|                                     |          |
|-------------------------------------|----------|
| Room Size                           | 313 ft2  |
| Room Volume (Assuming 8 ft ceiling) | 2504 ft3 |
| Room Volume                         | 71 m3    |
| Evacuation Rate                     | 380 CFM  |
| Ventilation Rate                    | 85 CFM   |
| Evacuation Air Changes per Hour     | 9.1      |
| Ventilation Air Changes per Hour    | 2.0      |

|   |              |
|---|--------------|
| HEC for Residential Exposures (24 hr TWA) | 0.0040 mg/m3 |
| HEC for Occupational Exposures (8 hr TWA) | 0.0200 mg/m3 |
| Target MOE (Occupational and Residential) | 30           |

#### Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

#### Decline During Evacuation Cycle

##### Cycle Time = 20 Minutes

##### Cycle Time = 30 Minutes

##### Cycle Time = 60 Minutes

| Time (Min) | Zone 1 (mg/m3)  | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 Hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE | 8 Hr TWA (mg/m3) | 8 hr MOE | Time (Min) | Zone 1 (mg/m3) | 24 Hr TWA (mg/m3) | 24 hr MOE |
|------------|-----------------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|------------------|----------|------------|----------------|-------------------|-----------|
| 0          | 52.92           | 0          | 2.54E+00       | 5.28E-02          | 0         | 1.58E-01         | 0        | 0          | 5.57E-01       | 1.16E-02          | 0         | 3.46E-02         | 1        | 0          | 5.87E-03       | 1.22E-04          | 33        |
| 1          | 45.47           | 1          | 2.46E+00       |                   |           |                  |          | 1          | 5.39E-01       |                   |           |                  |          | 1          | 5.67E-03       |                   |           |
| 2          | 39.06           | 2          | 2.38E+00       |                   |           |                  |          | 2          | 5.21E-01       |                   |           |                  |          | 2          | 5.48E-03       |                   |           |
| 3          | 33.56           | 3          | 2.30E+00       |                   |           |                  |          | 3          | 5.03E-01       |                   |           |                  |          | 3          | 5.30E-03       |                   |           |
| 4          | 28.84           | 4          | 2.22E+00       |                   |           |                  |          | 4          | 4.86E-01       |                   |           |                  |          | 4          | 5.12E-03       |                   |           |
| 5          | 24.77           | 5          | 2.15E+00       |                   |           |                  |          | 5          | 4.70E-01       |                   |           |                  |          | 5          | 4.95E-03       |                   |           |
| 6          | 21.29           | 6          | 2.07E+00       |                   |           |                  |          | 6          | 4.54E-01       |                   |           |                  |          | 6          | 4.78E-03       |                   |           |
| 7          | 18.29           | 7          | 2.00E+00       |                   |           |                  |          | 7          | 4.39E-01       |                   |           |                  |          | 7          | 4.63E-03       |                   |           |
| 8          | 15.71           | 8          | 1.94E+00       |                   |           |                  |          | 8          | 4.25E-01       |                   |           |                  |          | 8          | 4.47E-03       |                   |           |
| 9          | 13.50           | 9          | 1.87E+00       |                   |           |                  |          | 9          | 4.10E-01       |                   |           |                  |          | 9          | 4.32E-03       |                   |           |
| 10         | 11.60           | 10         | 1.81E+00       |                   |           |                  |          | 10         | 3.97E-01       |                   |           |                  |          | 10         | 4.18E-03       |                   |           |
| 11         | 9.96            | 11         | 1.75E+00       |                   |           |                  |          | 11         | 3.84E-01       |                   |           |                  |          | 11         | 4.04E-03       |                   |           |
| 12         | 8.56            | 12         | 1.69E+00       |                   |           |                  |          | 12         | 3.71E-01       |                   |           |                  |          | 12         | 3.90E-03       |                   |           |
| 13         | 7.36E+00        | 13         | 1.63E+00       |                   |           |                  |          | 13         | 3.58E-01       |                   |           |                  |          | 13         | 3.77E-03       |                   |           |
| 14         | 6.32E+00        | 14         | 1.58E+00       |                   |           |                  |          | 14         | 3.46E-01       |                   |           |                  |          | 14         | 3.65E-03       |                   |           |
| 15         | 5.43E+00        | 15         | 1.53E+00       |                   |           |                  |          | 15         | 3.35E-01       |                   |           |                  |          | 15         | 3.52E-03       |                   |           |
| 16         | 4.67E+00        | 16         | 1.48E+00       |                   |           |                  |          | 16         | 3.24E-01       |                   |           |                  |          | 16         | 3.41E-03       |                   |           |
| 17         | 4.01E+00        | 17         | 1.43E+00       |                   |           |                  |          | 17         | 3.13E-01       |                   |           |                  |          | 17         | 3.29E-03       |                   |           |
| 18         | 3.44E+00        | 18         | 1.38E+00       |                   |           |                  |          | 18         | 3.02E-01       |                   |           |                  |          | 18         | 3.18E-03       |                   |           |
| 19         | 2.96E+00        | 19         | 1.33E+00       |                   |           |                  |          | 19         | 2.92E-01       |                   |           |                  |          | 19         | 3.08E-03       |                   |           |
| 20         | <b>2.54E+00</b> | 20         | 1.29E+00       |                   |           |                  |          | 20         | 2.83E-01       |                   |           |                  |          | 20         | 2.97E-03       |                   |           |

## Appendix A - Quat Air Concentrations for Vital Oxide Fogging

### Spreadsheet 4 -Ambulance

#### Application Assumptions

|                             |               |
|-----------------------------|---------------|
| Amount Ai in Product        | 0.25 percent  |
| Application Rate of Product | 50 cm3/minute |
| Application Time            | 10 Minutes    |
| Amount Product Applied      | 500 cm3       |
| Amount Ai Applied           | 1250 mg       |

#### Evacuation and Ventilation Assumptions

|                                     |         |
|-------------------------------------|---------|
| Room Size                           | 100 ft2 |
| Room Volume (Assuming 6 ft ceiling) | 600 ft3 |
| Room Volume                         | 17 m3   |
| Evacuation Rate                     | 89 CFM  |
| Ventilation Rate                    | 20 CFM  |
| Evacuation Air Changes per Hour     | 8.9     |
| Ventilation Air Changes per Hour    | 2.0     |

|   |              |
|---|--------------|
| HEC for Residential Exposures (24 hr TWA) | 0.0040 mg/m3 |
| HEC for Occupational Exposures (8 hr TWA) | 0.0200 mg/m3 |
| Target MOE (Occupational and Residential) | 30           |

#### Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

#### Decline During Evacuation

|               |                   | Evac Time = 20 Minutes |                   |                     |             | Evac Time = 30 Minutes |                   |                     |             | Evac Time = 60 Minutes |                   |                     |             |
|---------------|-------------------|------------------------|-------------------|---------------------|-------------|------------------------|-------------------|---------------------|-------------|------------------------|-------------------|---------------------|-------------|
| Time<br>(Min) | Zone 1<br>(mg/m3) | Time<br>(Min)          | Zone 1<br>(mg/m3) | 8 Hr TWA<br>(mg/m3) | 8 hr<br>MOE | Time<br>(Min)          | Zone 1<br>(mg/m3) | 8 Hr TWA<br>(mg/m3) | 8 hr<br>MOE | Time<br>(Min)          | Zone 1<br>(mg/m3) | 8 Hr TWA<br>(mg/m3) | 8 hr<br>MOE |
| 0             | 73.62             | 0                      | 3.79E+00          | 2.40E-01            | 0           | 0                      | 8.59E-01          | 5.43E-02            | 0           | 0                      | 1.00E-02          | 6.34E-04            | 32          |
| 1             | 63.47             | 1                      | 3.66E+00          |                     |             | 1                      | 8.31E-01          |                     |             | 1                      | 9.69E-03          |                     |             |
| 2             | 54.71             | 2                      | 3.54E+00          |                     |             | 2                      | 8.04E-01          |                     |             | 2                      | 9.38E-03          |                     |             |
| 3             | 47.17             | 3                      | 3.43E+00          |                     |             | 3                      | 7.77E-01          |                     |             | 3                      | 9.07E-03          |                     |             |
| 4             | 40.67             | 4                      | 3.31E+00          |                     |             | 4                      | 7.52E-01          |                     |             | 4                      | 8.77E-03          |                     |             |
| 5             | 35.06             | 5                      | 3.21E+00          |                     |             | 5                      | 7.27E-01          |                     |             | 5                      | 8.48E-03          |                     |             |
| 6             | 30.23             | 6                      | 3.10E+00          |                     |             | 6                      | 7.03E-01          |                     |             | 6                      | 8.20E-03          |                     |             |
| 7             | 26.06             | 7                      | 3.00E+00          |                     |             | 7                      | 6.80E-01          |                     |             | 7                      | 7.94E-03          |                     |             |
| 8             | 22.46             | 8                      | 2.90E+00          |                     |             | 8                      | 6.58E-01          |                     |             | 8                      | 7.68E-03          |                     |             |
| 9             | 19.37             | 9                      | 2.81E+00          |                     |             | 9                      | 6.36E-01          |                     |             | 9                      | 7.42E-03          |                     |             |
| 10            | 16.70             | 10                     | 2.71E+00          |                     |             | 10                     | 6.15E-01          |                     |             | 10                     | 7.18E-03          |                     |             |
| 11            | 14.39             | 11                     | 2.62E+00          |                     |             | 11                     | 5.95E-01          |                     |             | 11                     | 6.94E-03          |                     |             |
| 12            | 12.41             | 12                     | 2.54E+00          |                     |             | 12                     | 5.76E-01          |                     |             | 12                     | 6.72E-03          |                     |             |
| 13            | 1.07E+01          | 13                     | 2.46E+00          |                     |             | 13                     | 5.57E-01          |                     |             | 13                     | 6.50E-03          |                     |             |
| 14            | 9.22E+00          | 14                     | 2.37E+00          |                     |             | 14                     | 5.39E-01          |                     |             | 14                     | 6.28E-03          |                     |             |
| 15            | 7.95E+00          | 15                     | 2.30E+00          |                     |             | 15                     | 5.21E-01          |                     |             | 15                     | 6.08E-03          |                     |             |
| 16            | 6.86E+00          | 16                     | 2.22E+00          |                     |             | 16                     | 5.04E-01          |                     |             | 16                     | 5.88E-03          |                     |             |
| 17            | 5.91E+00          | 17                     | 2.15E+00          |                     |             | 17                     | 4.87E-01          |                     |             | 17                     | 5.69E-03          |                     |             |
| 18            | 5.10E+00          | 18                     | 2.08E+00          |                     |             | 18                     | 4.71E-01          |                     |             | 18                     | 5.50E-03          |                     |             |
| 19            | 4.39E+00          | 19                     | 2.01E+00          |                     |             | 19                     | 4.56E-01          |                     |             | 19                     | 5.32E-03          |                     |             |
| 20            | <b>3.79E+00</b>   | 20                     | 1.94E+00          |                     |             | 20                     | 4.41E-01          |                     |             | 20                     | 5.14E-03          |                     |             |